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(54) ACCESS METHOD AND GSM REPEATER SYSTEM WITH SPECTRAL EXCHANGE BETWEEN THE 900 AND 1800 MHZ GSM WAVE FREQUENCIES

(57) It describes the architecture of repeaters for GSM with spectral interchange between the GSM frequency bands of 900 and 180 MHz.

The system comprises:

- one or several GSM cellular base stations.
- one or several near repeaters.
- one or several remote repeaters.

One or several GSM cellular remote terminals.

The GSM stations operate in the 900 MHz frequency band and service the near terminals in that band and are connected via cable with one or several near repeaters.

The near repeaters communicate with one or several remote repeaters in the 1800 MHz band via radio.

The remote repeaters communicate with the near repeaters in the 1800 MHz band and with the remote terminals in the 900 MHz band.

The remote terminals communicate with the base station through the repeater system.

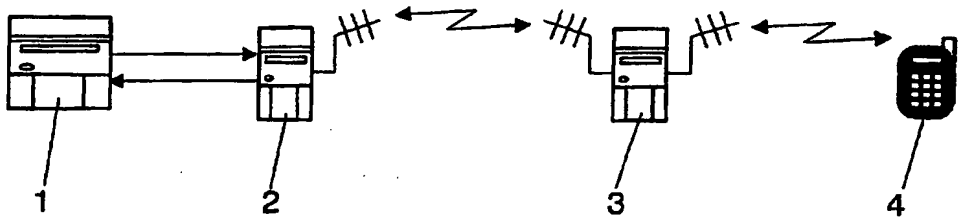

FIG. 1

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Description

FIELD OF APPLICATION

[0001] This invention describes an access method and GSM repeater system with espectral exchange between the 900 and 1800 MHz GSM wave frequencies

[0002] The frequency bands of 900 and 1800 MHz are assigned to the GSM cellular system of mobile communications, whereby the system does not require the operator to obtain any extra allocation of frequency bands from the competent regulatory body. Also, other spectral interchange repeater systems are already known which require spectral inversion or change in the information actually transported in the GSM channels, which is avoided by means of the system and method proposed.

CURRENT STATE OF THE ART

[0003] The need is known for radiofrequency signal repeaters or retransmitters in diverse circumstances, such as non-direct access on the part of the terminals to the transmit/receive centres when the distance between them is excessive or intervening obstacles are present. In general, the attenuation suffered in the level of the received signal does not allow communication between them, for which reason intermediate repeaters are required through which an indirect communication is allowed.

[0004] The use is known of radiofrequency signal repeaters by means of spectral band change in many systems via radio, like for example that which has been employed for many years in television signal repeaters. In them, a transmitting centre transmits signals in a frequency band B1. This band is received by the remote repeater or retransmitter, which re-transmits the received band in another frequency band B2. The change of frequency bands avoids coupling or mutual interference between the transmitted signal and the received one. The repeater can carry out additional functions such as amplification and regeneration of the signal. It is thus achieved that remote terminals without direct access to the transmitting centre, can have access to said transmitting centre indirectly. When the communication has to be bidirectional as is the case of cellular communications, the repeater has to work in both directions of communication.

[0005] The GSM cellular system is a system with TDMA channelling, having the frequency bands of 900 and 1800 MHz assigned, which in turn are divided into several sub-bands and each one into radio channels by means of TDMA techniques. Each channel allows communication between originator and receiver. In the case of GSM, the retransmission can be made independently for each of the radio channels, although the method most employed is for complete frequency sub-bands.

[0006] The concept is known in cellular communications like GSM of a remote repeater connected via radio to another near repeater, which will be in communication with the base station or transmit/receive centre. The frequency bands used between the base station and the near repeater, and between the near and remote repeater will be different. When in the hop between the near and remote repeater, the actual frequencies assigned to the communications system are used, there exists the risk of some cellular terminals interfering in the communication between repeaters, and to avoid this, various methods are available on the market and are in use. By way of example, there are the spectrum inversion of the GSM radio channel and modification of the information transported by the GSM signal. In the spectrum inversion, the band B used by the radio channel [Fa-B/2, Fa+B/2] is inverted completely with respect to its centre point Fa, converting any frequency Fa+x into image frequency Fa-x for any value inside the band. In the modification of the information transported by the GSM signal, demodulation is required in the near repeater to modify the BCCH/SCH channel, being modulated again before being sent to the remote repeater, and in like manner in the remote repeater demodulation is required again to undo the changes made in the BCCH/SCH channel and re-modulation before being forwarded to the final remote antenna.

Spectral change is not known in the state of the art between the GSM bands of 900 and 1800 MHz without spectral inversion and using the SCH channel of the GSM signal at 900 MHz as reference frequency.

[0007] The use is not known in the state of the art of spectral displacement of the radio channels between the near and remote repeater in order to prevent interference from cellular terminals which may be using the same frequency band.

DESCRIPTION OF THE INVENTION

[0008] The present invention discloses the architecture of a repeater system for GSM, with spectral interchange between the GSM frequency bands of 900 and 1800 MHz, and which is constituted by a GSM cellular base station, one or several near repeaters, one or several remote repeaters and GSM cellular remote terminals. Also, a complete system typically includes the presence of several base stations and both near and remote terminals.

[0009] The GSM base station operates in the 900 MHz frequency band, giving GSM cellular communications service to the near terminals inside its coverage area. It will also be connected to one or several near repeaters in the 900 MHz frequency band by connection via cable.

[0010] In turn, a near repeater will communicate with one or several remote repeaters in the 1800 MHz band via radio, forwarding in the downlink direction the radio channels transmitted by the base station to the remote repeater, and receiving in the uplink direction the radio channel or radio channels from the remote repeater and

forwarding them to the base station.

[0011] Each remote repeater will communicate with a near repeater in the 1800 MHz band and with the remote terminals in the 900 MHz band. In the downlink direction, the radio channels coming from the near repeaters in the 1800 MHz band are translated to the 900 MHz band and sent to the remote terminals in the 900 MHz band. In the uplink direction, the radio channels transmitted by the remote terminals in the 900 MHz band are forwarded to the near repeaters in the 1800 MHz band.

[0012] The remote terminals will communicate with the base station through the repeater system. From the functional point of view, the remote terminal will communicate with the remote repeater like any other near terminal directly connected to the base station.

[0013] Among the main characteristics of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz, are:

- The absence of inversion in the frequency bands of the radio channels in the spectral interchange between the bands of 900 and 1800 MHz.
- The use of the SCH channel for the extraction of the reference frequency used in the spectral interchange between the bands of 900 and 1800 MHz.
- To prevent any terminal operating in the GSM band of 1800 MHz from interfering in the communication between the near and remote repeaters, an object of this invention is the displacement of the channelling of this band assigned by ETSI in the GSM standard by a small amount (e.g. 100 kHz), which allows continuing inside the GSM frequency band of 1800 MHz according to ETSI standards and prevents intruding terminals from interfering in the communication between the repeaters.
- In the event of there being several remote repeaters, an object of this invention is the incorporation of a transmission cut-off mechanism in the uplink direction in the communication between the remote and near repeaters in the 1800 MHz band. The cutting-off of a radio channel will take place when the level of the signal to be repeated in the 900 MHz band does not exceed a threshold preset by the operator.
- All the necessary frequency changes in both the near and remote repeaters, are carried out by means of frequency synthesizers which use as master frequency that employed by the FCCH channel. The accuracy of these synthesizers has to be quite high so that the system works correctly (e. g. 0.05 ppm).
- Both near and remote repeaters incorporate a radio modem and a local control interface, through which an external management system can select the transmit and receive frequencies of the repeaters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Figure 1 shows the architecture of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz.

Figure 2 shows the architecture of the radiofrequency repeater module located in the near repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

Figure 3 shows the architecture of the radiofrequency repeater module located in the remote repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

Figure 4 shows the architecture of the control module of multiple near repeaters of the base station.

Figure 5 shows the architecture of the control module of a remote repeater of the base station.

Figure 6 shows the architecture of the high-performance synchronisation extractor element which generates an intermediate frequency signal from the FCCH channel of the GSM frame and a minimum phase error algorithm.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Figure 1 shows the entities involved in the architecture of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz: GSM cellular base station (1), near repeater (2), remote repeater (3) and GSM cellular remote terminal (4).

[0016] There can be one or several near repeaters, remote repeaters and remote terminals. A complete system includes typically the presence of several base stations and both near and remote terminals. All this is not detailed in figure 1 as it is unnecessary from the point of view of describing the invention.

[0017] The GSM base station (1) operates in the frequency band of 900 MHz.

[0018] Typically it will have sectorial antennas in order to increase the efficiency of the system as to traffic and number of near terminals supported simultaneously. This base station (1) will have near terminals which will be connected directly via radio to said base station (1), and it will also be connected to one or several near repeaters (2) in the 900 MHz band by means of connection via cable.

[0019] The near repeater (2) will communicate with the base station (1) in the 900 MHz band via cable and with the remote repeater (3) (one or several remote repeaters) in the 1800 MHz band via radio. The near re-

peater (2) will receive in the downlink direction the radio channels transmitted by the base station (1) and will forward them to the remote repeater (3). It includes the BCCH, FCCH and SCH channels necessary for the synchronisation of the remote terminals (4) and for the actual operation of the near repeaters (2). Typically, the communication with the base station (1) and with the remote repeater (3) will be carried out using directional antennas to increase efficiency in the communication. In the uplink direction, the near repeater (2) will receive the radio channel or radio channels from the remote repeater (3) and will forward them to the base station (1).

[0020] The remote repeater (3) will communicate with the near repeater (2) in the 1800 MHz band and with the remote terminals (4) in the 900 MHz band. The remote repeaters (3) will typically use directional antennas for communication with the near repeaters (2) and sectorial antennas for communication with the remote terminals (4). In the downlink direction, the radio channels coming from the near repeaters in the 1800 MHz band are translated to the 900 MHz band and sent to the remote terminals (4). This includes the BCCH, FCCH and SCH channels necessary for the synchronisation of the remote terminals (4) and for the actual operation of the remote repeaters (3). In the uplink direction, the radio channels transmitted by the remote terminals (4) in the 900 MHz band are forwarded to the near repeaters in the 1800 MHz band.

[0021] The remote terminals (4) will communicate with the remote repeater (3) in the 900 MHz band. In fact they will communicate with the base station (1) through the repeater system. From the functional point of view, the remote terminal (4) will communicate with the remote repeater like any other near terminal directly connected to the base station (1). For the correct operation of the system, the BCCH, FCCH and SCH channels are radiated by the remote repeater (3), which were originally transmitted by the base station (1) and forwarded by the near repeater (2).

[0022] Among the main characteristics of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz, are:

- The absence of inversion in the frequency bands of the radio channels in the spectral interchange between the bands of 900 and 1800 MHz.
- The use of the SCH channel for the extraction of the reference frequency used in the spectral interchange between the bands of 900 and 1800 MHz.
- To prevent any terminal operating in the GSM band of 1800 MHz from interfering in the communication between the near (2) and remote (3) repeaters, an object of this invention is the displacement of the channelling of this band assigned by ETSI in the GSM standard by a small amount (e.g. 100 kHz), which allows continuing inside the GSM frequency band of 1800 MHz according to ETSI standards and prevents intruding terminals from interfering in the communication between the repeaters.
- In the event of there being several remote repeaters (3), an object of this invention is the incorporation of a transmission cut-off mechanism in the uplink direction in the communication between the remote (3) and near (2) repeaters in the 1800 MHz band. The cutting-off of a radio channel will take place when the level of the signal to be repeated in the 900 MHz band does not exceed a threshold preset by the operator.
- All the necessary frequency changes in the repeaters both near (2) and remote (3), are carried out by means of frequency synthesizers which use as master frequency that employed by the FCCH channel. The accuracy of these synthesizers has to be quite high so that the system works correctly (e. g. 0.1 ppm). Figure 6 shows this element in more detail.
- Both near (2) and remote (3) repeaters incorporate a radio modem and a local control interface, through which an external management system can select the transmit and receive frequencies of the repeaters. Particulars of the control modules for the near (2) and remote (3) repeaters are shown in detail in figures 4 and 5 respectively.

[0023] In figure 1, the letters A to C denote the interfaces between the diverse entities. These interfaces are:

A- Interface between the base station (1) and the near repeaters (2). This interface is via radio in the GSM band of 900 MHz in accordance with the ETSI standards.

B- Interface between the near repeaters (2) and the remote repeaters (3). This interface is via radio in the GSM band of 1800 MHz in accordance with the ETSI standards.

C- Interface between the remote repeaters (3) and the remote terminals (4). This interface is via radio in the GSM band of 900 MHz in accordance with the ETSI standards.

[0024] Figure 2 shows the main entities of the preferred architecture of the radiofrequency repeater module located in the near repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz. In the downlink subunit: low noise amplifier of GSM line at 900 MHz (6), GSM band filter at 900 MHz (8), first mixer (10), first synthesizer (12), synchronisation extractor (5), second mixer (11), second synthesizer (13), GSM band filter at 1800 MHz (9) and GSM amplifier at 1800 MHz (7). In the uplink subunit: GSM low noise amplifier at 1800 MHz (14), GSM band filter at 1800 MHz (16), first mixer (19), first synthesizer (21), intermediate band filter (17), second mixer (20), second synthesizer (22), GSM band filter at 900 MHz (18) and GSM line amplifier at 900 MHz (18). Other mod-

ules: GSM duplexer at 1800 MHz (23).

[0025] Other modules are not detailed in this figure, such as the 1800 MHz antennas nor the control module of the near repeater (2). This last item is detailed in figure 4.

[0026] In the downlink subunit a single GSM channel is received via cable from the base station (1) in the 900 MHz band, which after mixing (10) with a first local oscillator (12) is converted into an intermediate frequency signal. This point is that employed for synchronisation extraction (5), generating a reference clock signal (e.g. 13 MHz) both for the downlink and uplink subunit. The intermediate frequency signal is again mixed (11) with the signal of a second oscillator (13) to obtain the GSM signal at 1800 MHz which will be transmitted to the remote repeater (3).

[0027] In a similar way, in the uplink subunit a GSM channel is received from the remote repeater (3) in the 1800 MHz band, which after mixing (19) with a first local oscillator (21) is converted into an intermediate frequency signal. The intermediate frequency signal is again mixed (20) with a second oscillator (22) to obtain the GSM signal at 900 MHz which will be transmitted via cable to the base station (1).

[0028] It is noteworthy that all the synthesizers use as reference signal that generated by the synchronisation extractor detailed in the downlink subunit, whereby the frequency accuracy of all of them can be assured.

[0029] Figure 3 shows the architecture of the radiofrequency repeater module located in the remote repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz. In the downlink subunit: GSM low noise amplifier at 1800 MHz (25), GSM band filter at 1800 MHz (27), first mixer (30), first synthesizer (32), intermediate band filter (28), synchronisation extractor (24), second mixer (31), second synthesizer (33), GSM band filter at 900 MHz (29) and GSM amplifier at 900 MHz (26). In the uplink subunit: GSM low noise amplifier at 900 MHz (34), GSM band filter at 900 MHz (36), first mixer (39), first synthesizer (41), intermediate band filter (37), second mixer (40), second synthesizer (42), GSM band filter at 1800 MHz (38) and GSM amplifier at 1800 MHz (35). Other modules: GSM duplexer at 900 MHz (43) and GSM duplexer at 1800 MHz (44).

[0030] Other modules are not detailed in this figure, such as the 900 and 1800 MHz antennas nor the control module of the remote repeater (3). This last item is detailed in figure 5.

[0031] In the downlink subunit a single GSM channel is received via radio from the near repeater (2) in the 1800 MHz band, which after mixing (30) with a first local oscillator (32) is converted into an intermediate frequency signal. This point is that employed for synchronisation extraction (24), generating a reference clock signal (e.g. 13 MHz) both for the downlink and uplink subunit. The intermediate frequency signal is again mixed (31) with the signal of a second oscillator (33) to obtain the GSM signal at 900 MHz which will be transmitted by remote repeater (3).

[0032] In a similar way, in the uplink subunit a GSM channel is received from the remote terminals (4) in the 900 MHz band, which after mixing (39) with the signal of a first local oscillator (41) is converted into an intermediate frequency signal. The intermediate frequency signal is again mixed (40) with the signal of a second oscillator (42) to obtain the GSM signal at 1800 MHz which will be transmitted via radio to the near repeaters (2).

[0033] It is noteworthy that all the synthesizers use as reference signal that generated by the synchronisation extractor detailed in the downlink subunit, whereby the frequency accuracy of all of them can be assured.

[0034] Figure 4 shows the entities of the architecture of the control module of multiple near repeaters of the base station: GSM modem (45), local interface module (46), RS-485 interface module (48) and microprocessor (47).

[0035] The control module allows the simultaneous control of up to 32 near repeaters (2) by means of a standard bus like for example RS-485. The control module carries out the communication with external devices through two interfaces, one local to a personal computer and another through a GSM modem using for this the GSM short message service.

[0036] Figure 5 shows the entities of the architecture of the control module of a remote repeater of the base station: GSM modem (49), local interface module (50), interface module with RF antenna module (52) and microprocessor (51).

[0037] The control module allows control of a single remote repeater (3). The control module carries out the communication with external devices through two interfaces, one local to a personal computer and another through a GSM modem using for this the GSM short message service.

[0038] Figure 6 shows the entities of the architecture of the high-performance synchronisation extractor element which generates an intermediate frequency signal from the FCCH channel of the GSM frame and an algorithm of minimum phase error. GSM demodulator: bandpass intermediate frequency filter (53), amplifier and I/Q demodulator (54) and synthesizer (55). Base band processing module: A/D converters (56), additional logic (57, 58 and 59) and digital signal processor (60).

[0039] The purpose of the synchronisation extractor module is to obtain a reference signal at 13 MHz synchronized to the FCCH channel of the GSM frame with a high accuracy better than 0.05 ppm. This reference signal is used by all the synthesizers of each local (2) or remote (3) repeater, generating all those necessary frequencies. The synchronisation extractor module allows the necessary accuracy in frequency to be maintained without having to use local oscillators (synthesizers) of very high accuracy (expensive).

[0040] The GSM demodulator will demodulate the in-

termediate frequency signal by means of a synthesizer and an I/Q demodulator, obtaining the in-phase and quadrature GSM base band analogue components.

[0041] The base band processing module incorporates a digital signal processor (DSP) which will handle the in-phase and quadrature GSM base band analogue data received after being converted to digital format by means of the corresponding analogue/digital (A/D) converters. The digital processor will control the synthesizer of the demodulator for the purpose of generating the reference signal in synchronisation with the FCCH channel.

DEFINITIONS AND ABBREVIATIONS

[0042]

A/D	Analogue to digital converter.
BCCH	Broadcast control channel in GSM. Channel multicasting from the base station to all the terminals of its coverage area.
DSP	Digital signal processor.
ETSI	European telecommunications standards institute.
FCCH	Frequency control channel in GSM.
GSM	Cellular radiofrequency communications system standardized and regulated by ETSI (Global System for Mobile communication).
kHz	Kilohertz. Unit of measurement of electric frequency.
MHz	Megahertz. Unit of measurement of electric frequency.
ppm	Parts per million. Employed typically to measure the accuracy of frequency synthesizers.
SCH	Synchronisation channel in GSM.
TDMA	Time division multiple access. System used to separate the different user data channels.

Claims

1. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz **characterised by** using the 900 MHz band to communicate with the GSM network and the 1800 MHz band to communicate between said repeaters.

2. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claim 1 **characterised by** having near repeaters connected to the base station in the 900 MHz band.

3. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 and 2 **characterised by** having remote repeaters connected to the near repeaters in the 1800 MHz band.

4. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 3 **characterised by** having cellular terminals connected in the 900 MHz band.

5. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 3 **characterised by** the spectral displacement of the radio channels in the communication at 1800 MHz between the near and remote repeaters to prevent the intrusion of GSM cellular terminals in said band.

6. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 3 **characterised by** the absence of inversion in the frequency bands of the radio channels in the spectral interchange between the bands of 900 and 1800 MHz.

7. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 3 **characterised by** using the SCH channel for the extraction of the reference frequency used in the spectral interchange between the bands of 900 and 1800 MHz.

8. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 3 **characterised by** a mechanism for cutting off transmission of the radio signal in the repeaters when the corresponding input signal is below a threshold adjustable by the operator.

9. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 8 **characterised by** the presence of a radiofrequency repeater module located in the near repeater to the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

10. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 9 **characterised by** the presence of a control module of multiple near repeaters of the base station.

11. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 8 **characterised by** the presence of a radiofrequency repeater module located in the remote repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

12. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 8 and 11 **characterised by** the presence of a remote repeater control module of the base station.

13. Repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 1 to 8 **characterised by** the presence of a synchronisation extractor element of high accuracy which generates an intermediate frequency signal based on the FCCH channel of the GSM frame and an algorithm of minimum phase error.

14. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz **characterised by** using the 900 MHz band to communicate with the GSM network and the 1800 MHz band to communicate between said repeaters.

15. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claim 14 **characterised by** having near repeaters connected to the base station in the 900 MHz band.

16. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 and 15 **characterised by** having remote repeaters connected to the near repeaters in the 1800 MHz band.

17. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 16 **characterised by** having cellular terminals connected in the 900 MHz band.

18. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 16 **characterised by** the spectral displacement of the radio channels in the communication at 1800 MHz between the near and remote repeaters to prevent the intrusion of GSM cellular terminals in said band.

19. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 16 **characterised by** the absence of inversion in the frequency bands of the radio channels in the spectral interchange between the 900 and 1800 MHz bands.

20. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 16 **characterised by** using the SCH channel for the extraction of the reference frequency used in the spectral interchange between the 900 and 1800 MHz bands.

21. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 16 **characterised by** a mechanism for cutting off transmission of the radio signal in the repeaters when the corresponding input signal is below a threshold adjustable by the operator.

22. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 21 **characterised by** the presence of a radiofrequency repeater module located in the near repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

23. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 22 **characterised by** the presence from a control module of multiple near repeaters of the base station.

24. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 21 **characterised by** the presence of a radiofrequency repeater module located in the remote repeater of the base station using spectral interchange between the GSM bands of 900 and 1800 MHz.

25. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 21 and 24 **characterised by** the presence of a control module of a remote repeater of the base station.

26. Access method of the repeater system for GSM with spectral interchange between the GSM frequency bands of 900 and 1800 MHz according to claims 14 to 21 **characterised by** the presence of a synchronisation extractor element of high accuracy which generates an intermediate frequency signal based on the FCCH channel of the GSM frame and an algorithm of minimum phase error.

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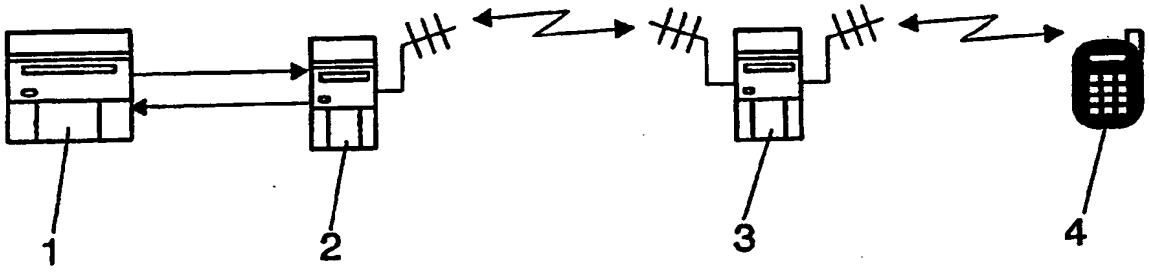

FIG. 1

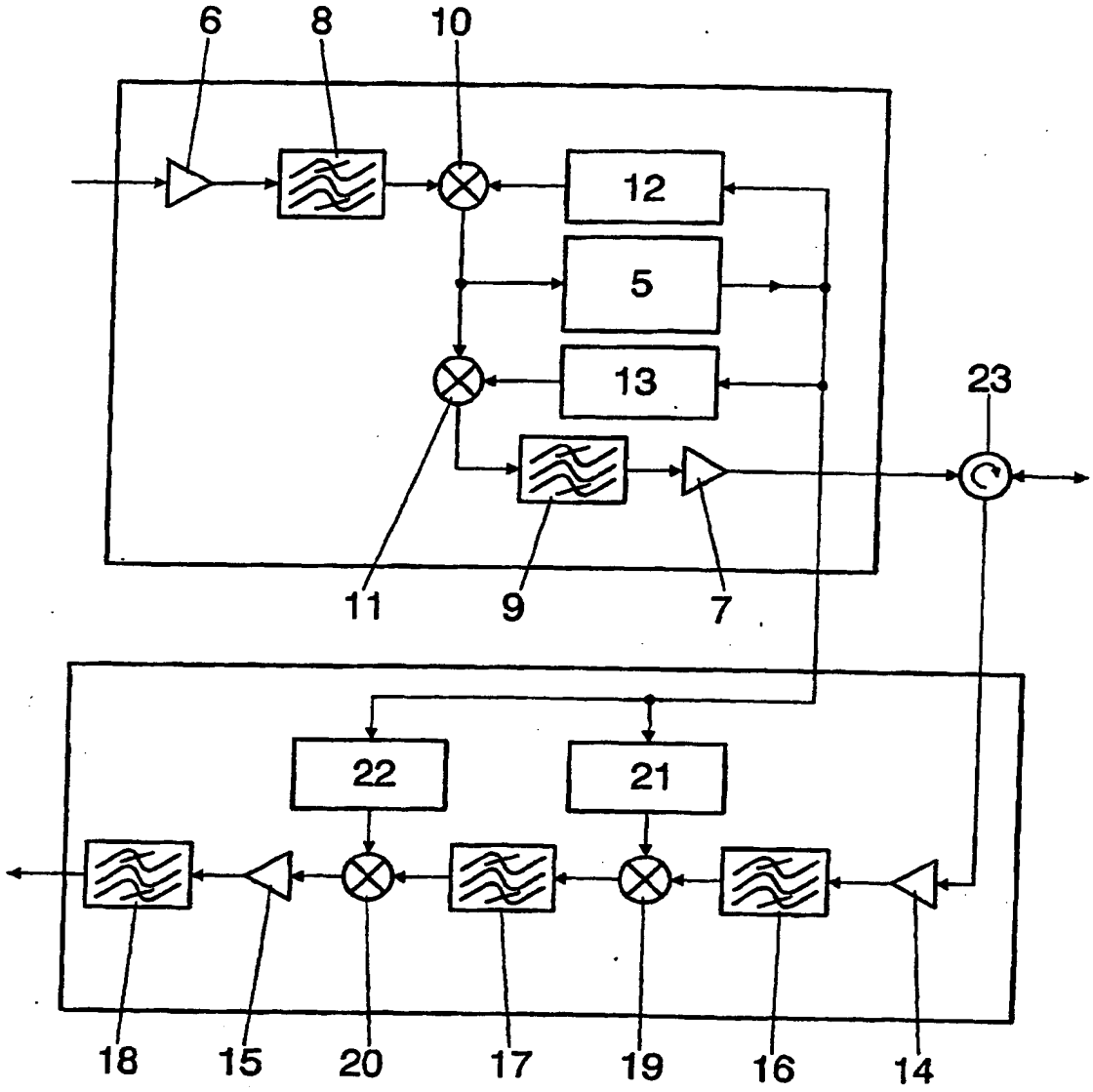

FIG. 2

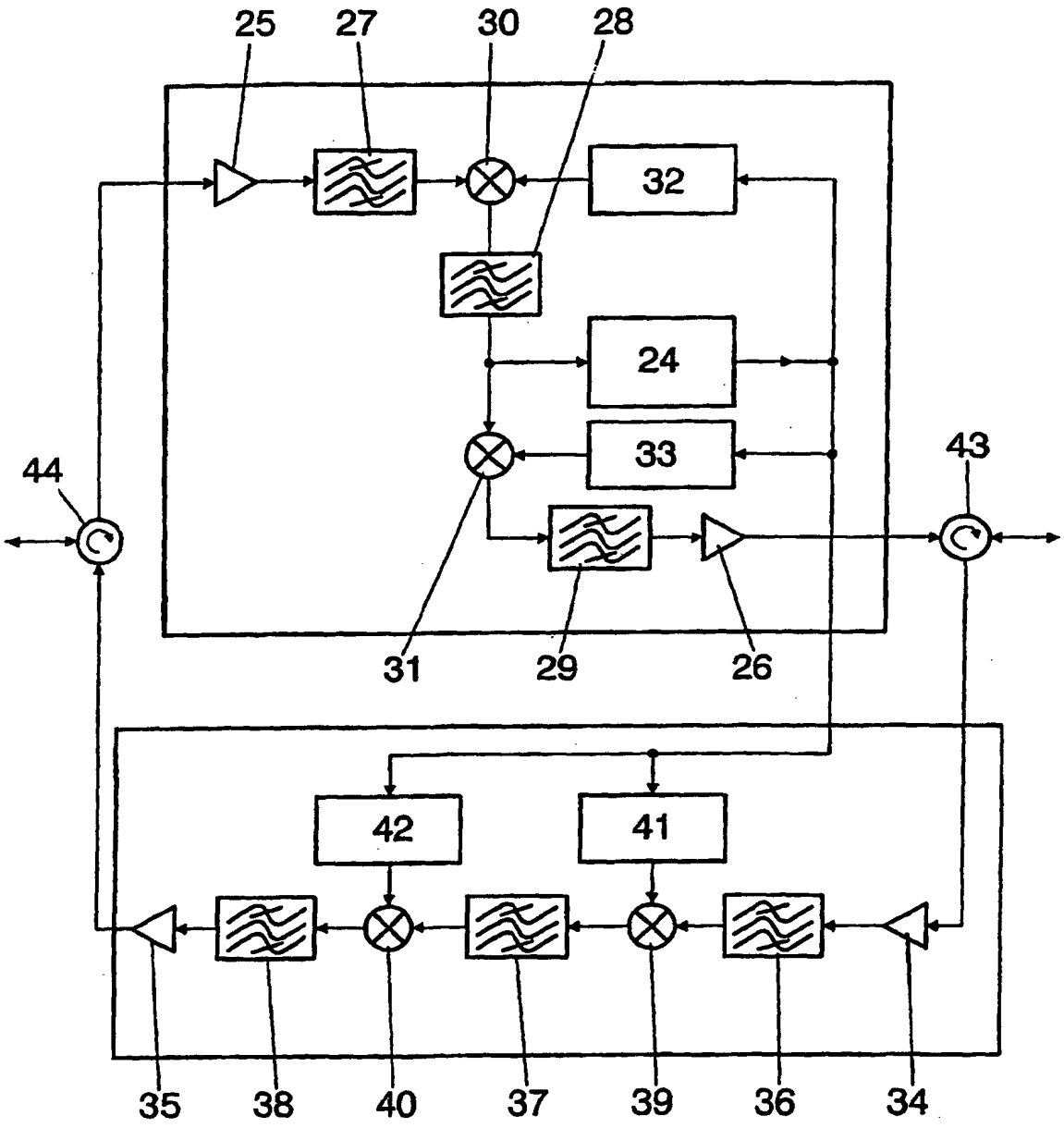

FIG. 3

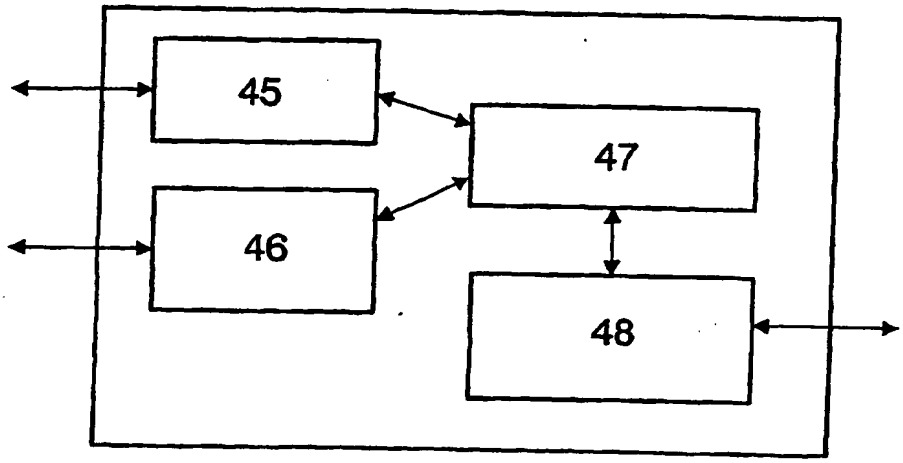

FIG. 4

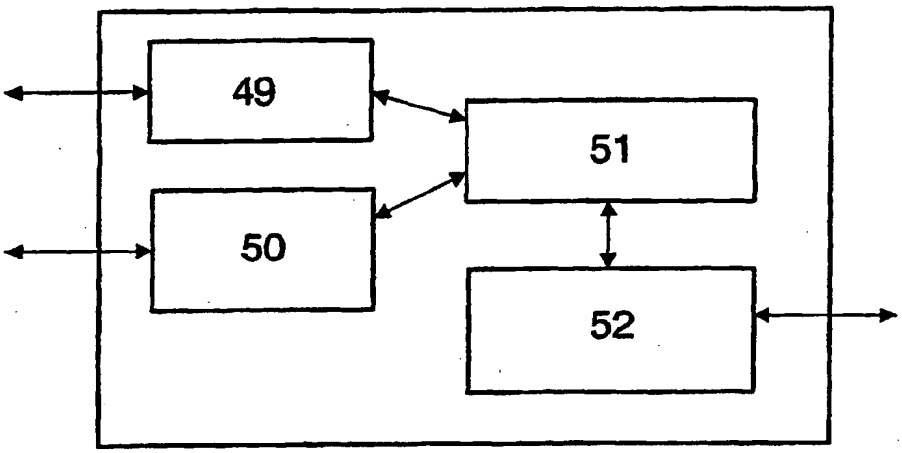

FIG. 5

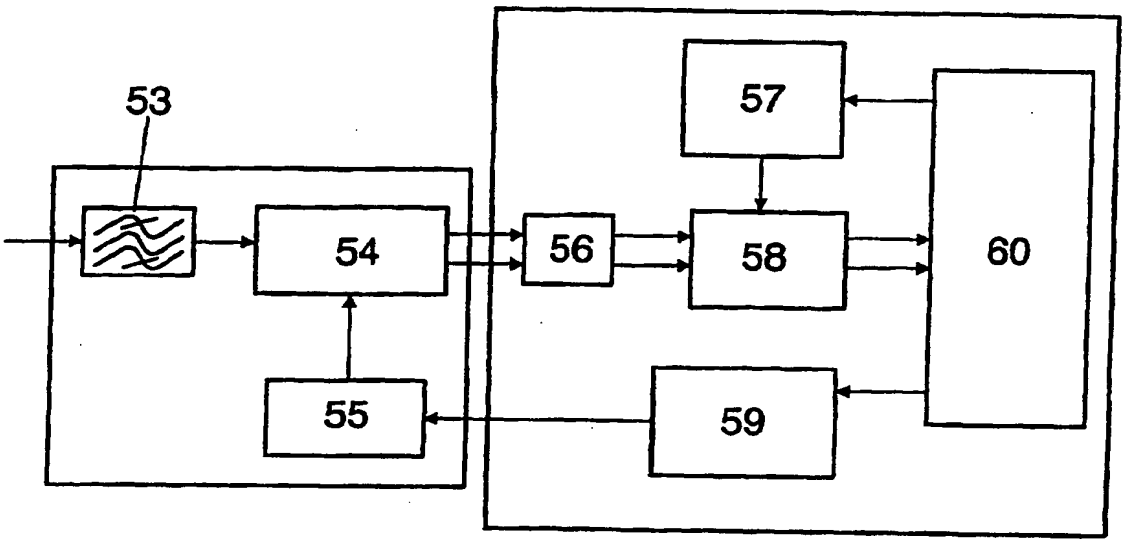

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES03/00169

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H 04 B 7/26 , H 04 B 7/15 , H 04 Q 7/20 , H 04 B 7/005 .
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H 04 B 7/26 , H 04 B 7/15 , H 04 Q 7/20 , H 04 B 7/005 .

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WIPL, PAJ, INSPEC , CIBEPAT.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 418103 A2 (PCN ONE LIMITED) 20.03.1991 ; **the whole document**	1,3,4,8,11,14, 16,17,21,24
Y	US 6426682 B1 (HERZBERG ET AL.) 30.07..2002 ; **the whole document**	1,3,4,11,14, 16,17,24
Y	EP 1020999 A1 (NORTEL MATRA CELLULAR) 19.07.2000 ; **the whole document**	1,3,8,14,16,21
A	EP 523687 A2 (FUJITSU LIMITED) 20.01.1993 ; **the whole document**	1-26
A	US 6373833 B1 (SUONVIERI ET AL.) 16.04.2002 ; **the whole document**	1-26

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 JUL. 2003 (18.07.03)	23 JUL 03 (23.07.03)
Name and mailing address of the ISA/ S.P.T.O. Facsimile No.	Authorized officer Telephone No.

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Information on patent family members

International Application No
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